MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2016/2017

EOP 4086-OPTICAL SIGNAL PROCESSING

(OPE)

29th May- 2017
9.00 A.M-11 A.M.
(2 Hours)

INSTRUCTION TO STUDENT

1.This Question paper consists of 4 pages including cover page with 4 Questions only.

2.Attempt **FOUR** out of **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3 Please print all your answers in the answer Booklet provided.

Question 1

(a) With the aid of suitable equations define and describe the dispersive power of a grating.

[8 marks]

(b) Describe with a simple diagram, the Fresnel diffraction due to straight edge.

[8 marks]

(c) Two spectral lines have wavelengths λ and $\lambda + d\lambda$ respectively.Show that if $d\lambda << \lambda$,the angular separation $d\theta$ in a grating spectrometer is a given by $d\theta = \frac{d\lambda}{\sqrt{\left(\frac{e+d}{n}\right)^2 - \lambda^2}}$,where $(e+d)$ is the grating element spacing and n is the order at which the lines are observed.

[9 marks]

Question 2

(a) Based on the theory of zone plate, show that the radii of circles are proportional to the square roots of natural numbers.

[14 marks]

(b) An object is placed at 20 cm from a zone plate and the brightest image is situated at 20 cm from the zone plate with a light of wavelength $\lambda = 4000A^0$. Calculate the number of Fresnel zones in a radius of 1 cm of that plate.

[7 marks]

(c) If light of $\lambda = 660nm$ has a wavetrains 20λ long,what are its coherence length and coherence time?

[4 marks]

Continued---

Question 3

(a) Describe one-dimensional Fourier transforms mathematically.

[12 marks]

(b) State and prove convolution theorem in Fourier optics.

[7 marks]

(c) The total path difference executed by a Fourier transform spectrometer operating in the infrared is 2.78 mm.Its range is from 4400 to $400\,\text{cm}^{-1}$.

(i) Calculate its resolution in wave number.

[2 marks]

(ii) How many data points must be taken over the scan to avoid aliasing within this range?

[2 marks]

(iii) What is the scan rate if one run is completed in 30 s?

[2 marks]

Given $x_w = 2.78mm$ $\lambda = (4400 - 400)\,cm^{-1}$

$4400cm^{-1} = 2.27\mu m$ $400cm^{-1} = 25\mu m$

Question 4

(a) Show that for a double-slit, slit width of b and widths separation of Fraunhofer diffraction, the ratio of widths of the central diffraction peak to the central interference fringe is $2\left(\frac{a}{b}\right)$.

[10 marks]

(b) Suppose that as a theoretical limit 1 bit of information can be stored in each λ^3 of volume hologram.At a wavelength of 492 nm and a refractive index of 1.30.Calculate the storage capacity of $1mm^3$ of volume hologram.

[6 marks]

(c) Suppose a hologram is to be made of a moving object using a 1-ns laser pulse at a wavelengrh of 633 nm.What is the permissible speed such that the object does not move more than $\frac{\lambda}{10}$ during the exposure?

[4 marks]

Continued---

(d) During the construction of a hologram , a beam splitter is selected that makes the amplitude of the reference beam eight times that of the signal beam at the emulsion. What is the maximum ratio of beam irradiances there?

[5 marks]

End of paper